

# Efficient Separations Technologies for Petroleum Refining



R. Bruce Eldridge  
Process Science and Technology Center  
The University of Texas

# PROCESS SCIENCE & TECHNOLOGY CENTER



UT - Austin



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## Alternative Sources for Fuels



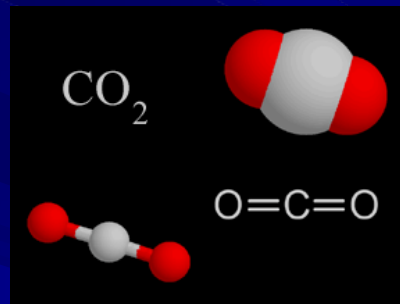
## Next Generation Fuel Consumers



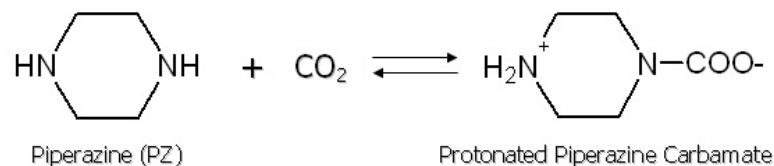
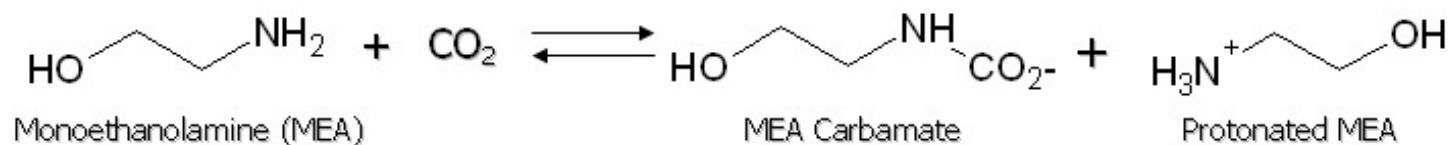


# Carbon Dioxide

Reduced energy CO<sub>2</sub> capture and sequestration approaches are critical if greenhouse gas emissions are to be reduced

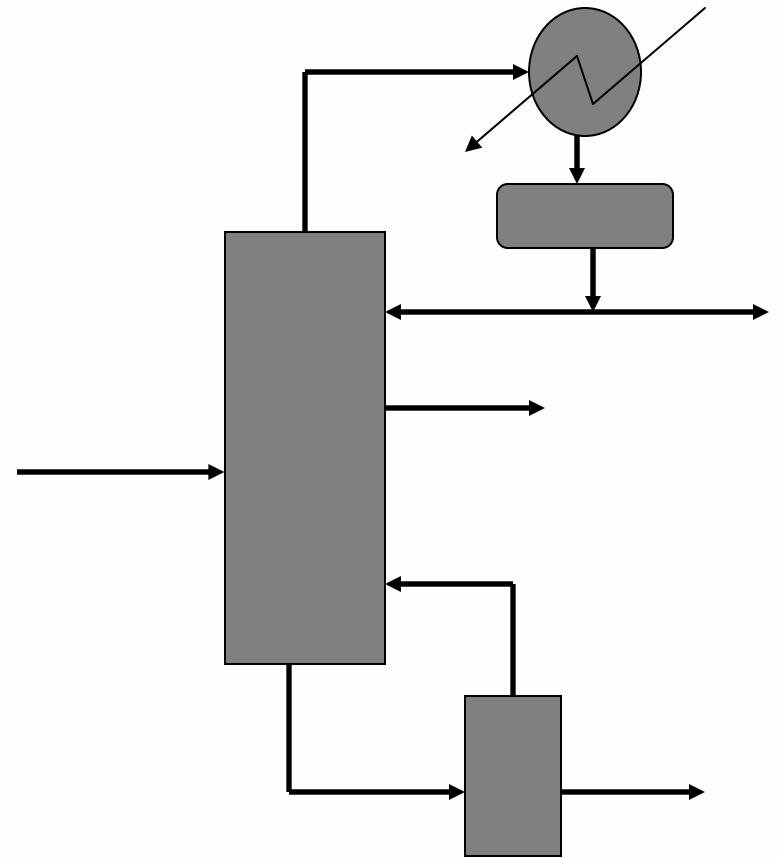


## Solvent Selection for CO<sub>2</sub> Capture



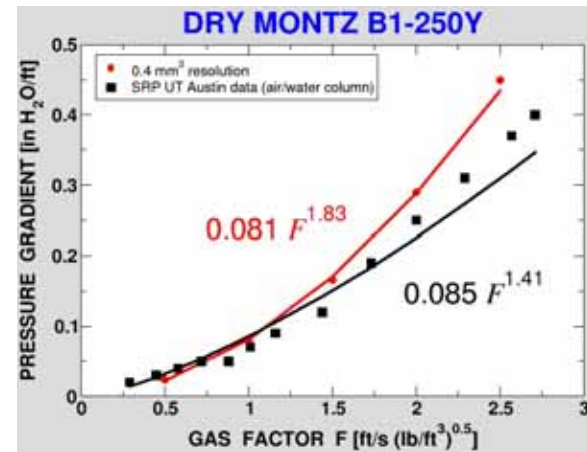
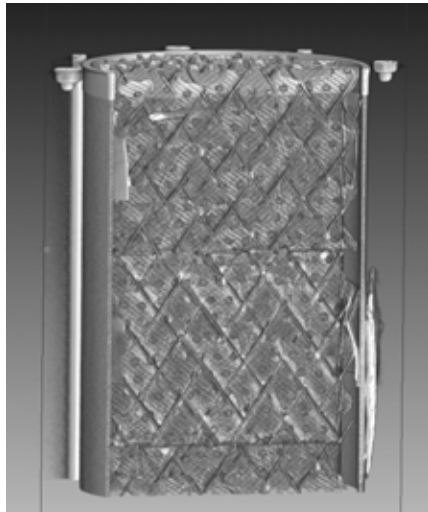
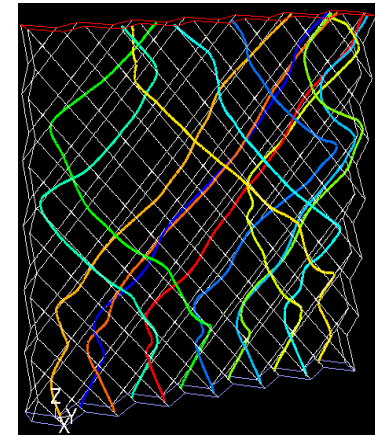
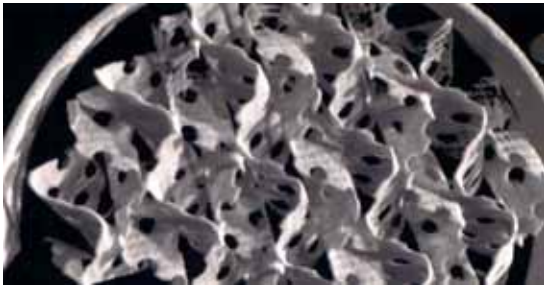


# Distillation



The Dinosaur Lives !!

## Reliable / Predictive Models





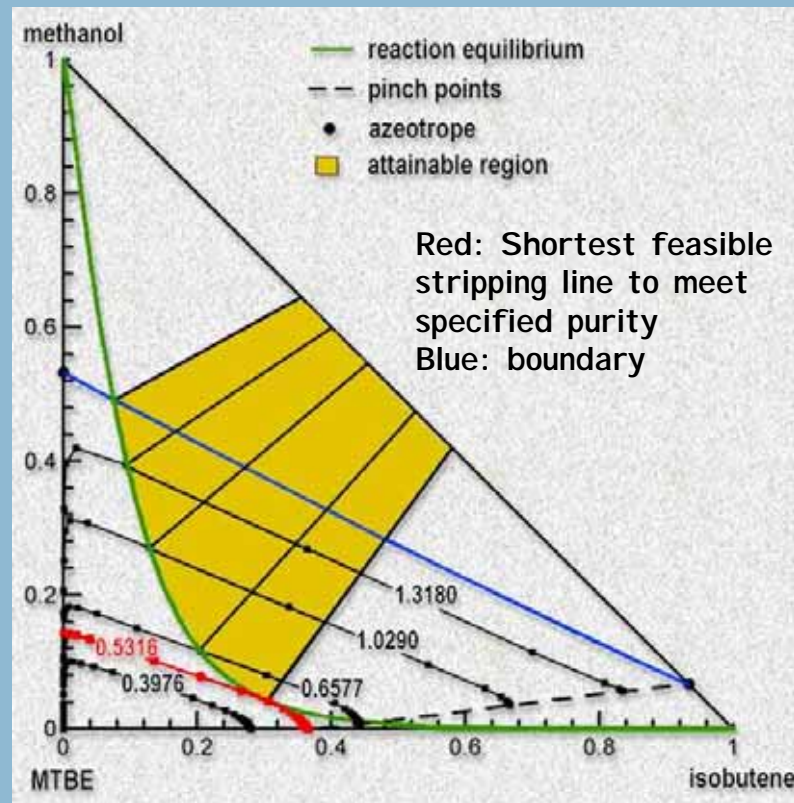
## Energy Consumption & Distillation Lines

Angelo Lucia (University of Rhode Island) and Ross Taylor (Clarkson University)

New approach to conceptual design of distillation systems based on the length of the composition profile.

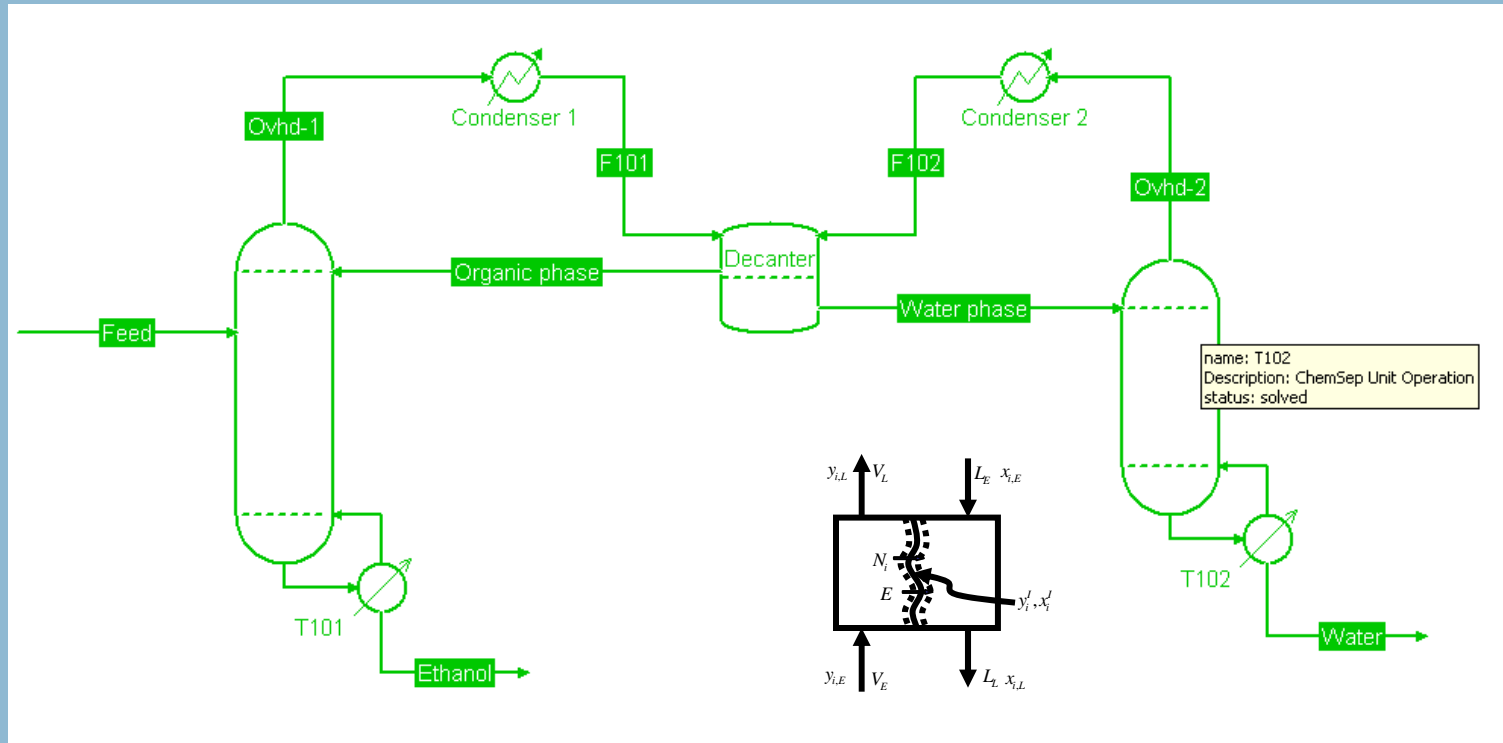
Longest distillation lines are  
approximations to boundaries  
most difficult separations  
least energy efficient

Shortest distillation lines are  
least difficult  
**most energy efficient**



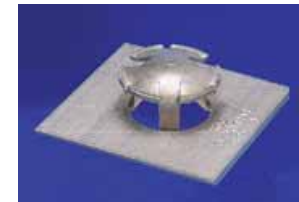
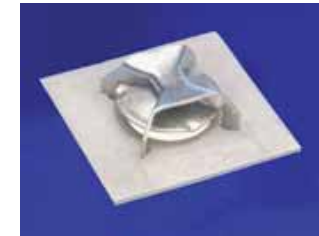
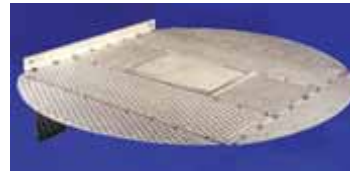
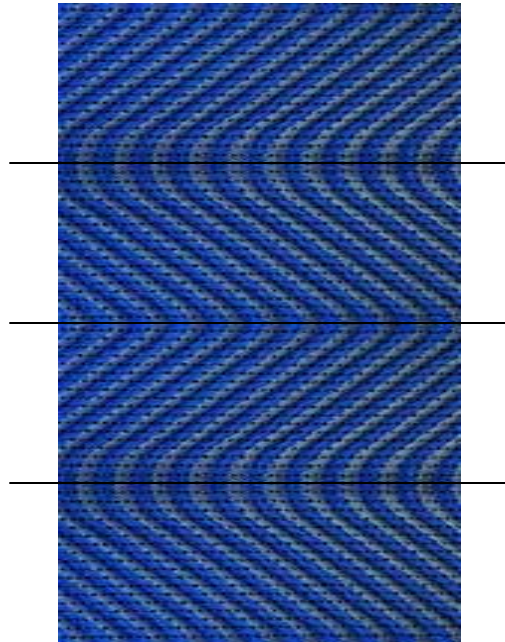
New approach can accommodate **mass transfer affects**; this influences: column height, minimum reflux, process feasibility.

ChemSep: CAPE-OPEN Compliant Column Simulator  
Ross Taylor and Harry Kooijman



- Features the original non-equilibrium column model.
- Tested with Aspen Plus, HYSYS, Pro/II, UNISIM Design
- ChemSep Lite supplied free with COCO ([www.cocosimulator.org](http://www.cocosimulator.org))
- Image shows ChemSep with COCO

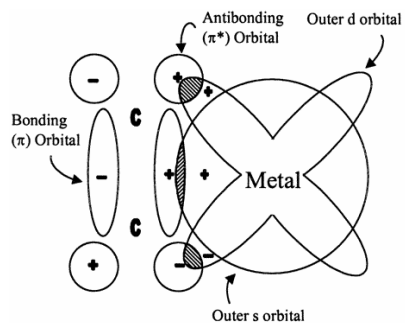
## High Capacity Column Internals



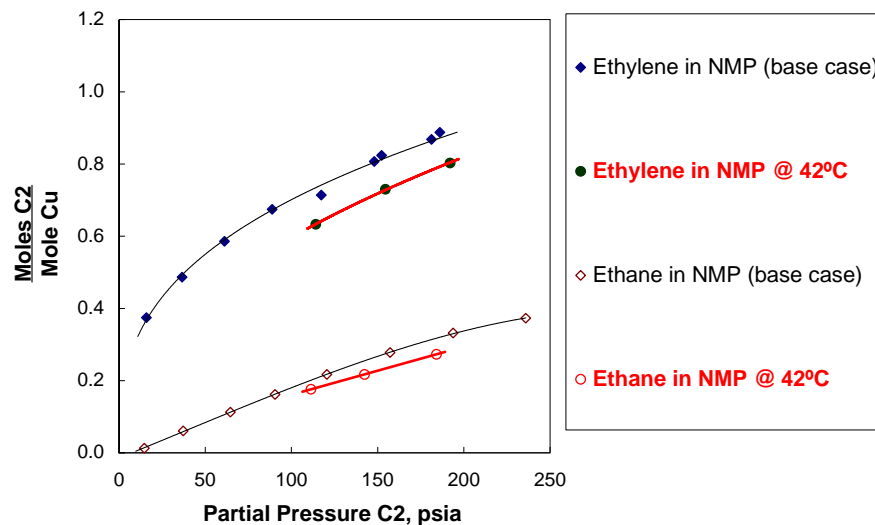
## Novel Technologies for Chemical Recovery



Cryogenic Distillation System

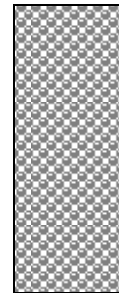


High temp: CuCl-Aniline-NMP @ 42°C





## Coupled Reactive / Separations for Chemical Production

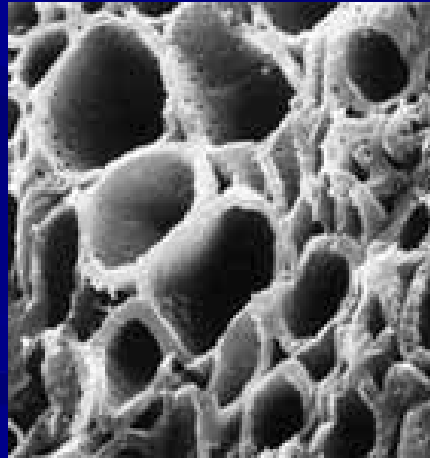


Catalytic section

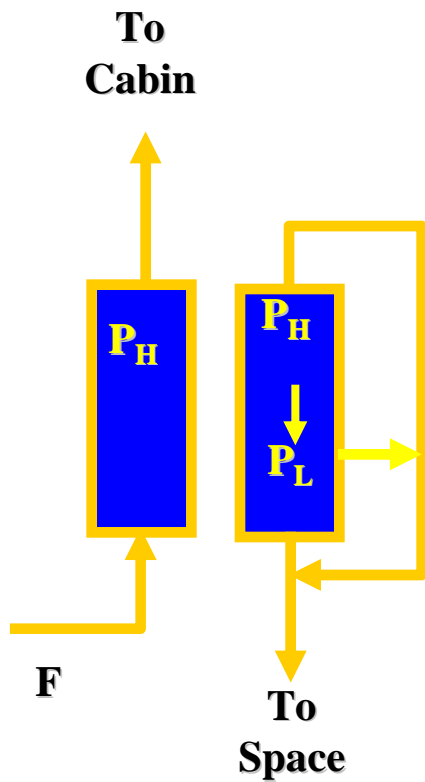
“Reactive Distillation”

# Adsorption Processes

Optimized Cycles / Configurations  
Novel adsorbent materials

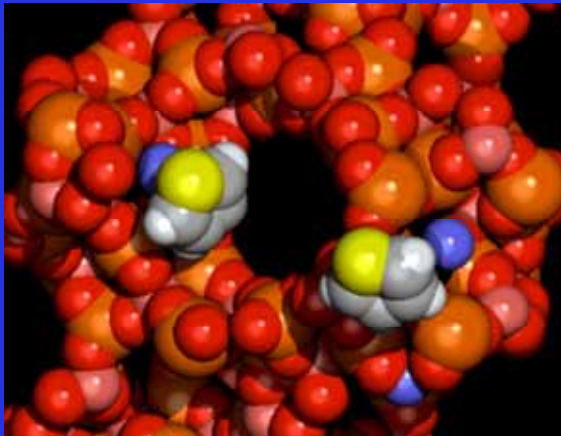


## Optimized Adsorption Cycles / Configurations



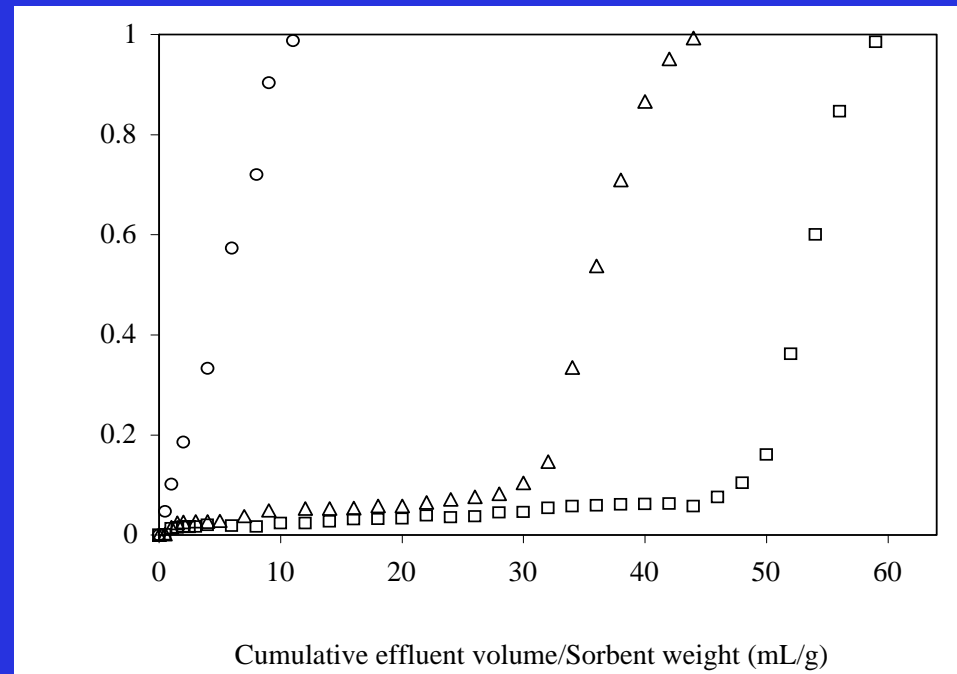
# Selective Adsorbents

Dr. Ralph Yang – Department of Chemical Engineering



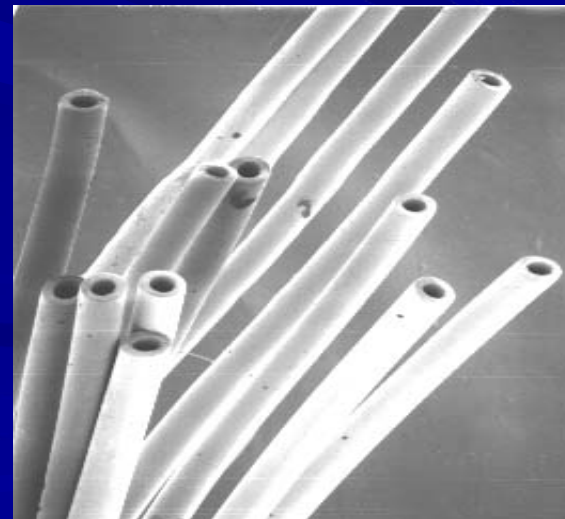
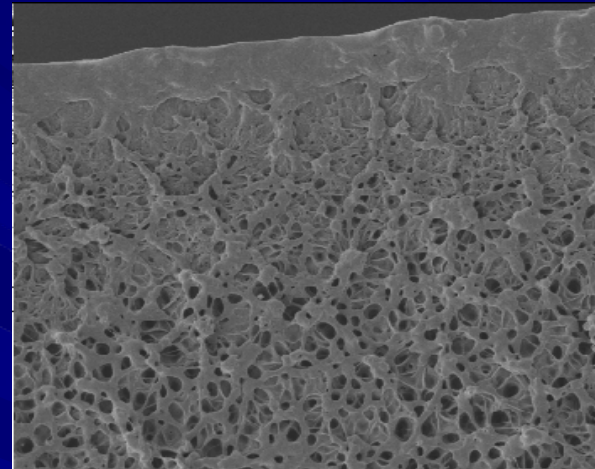
Thiophenic sulfur molecules are selectively bonded to the Cu<sup>+</sup> sites on the cavity of faujasite zeolite at room temperature.

Breakthrough of total sulfur in fixed-bed adsorber with SBA-15 (○), CuCl/SBA-15 (△) and PdCl<sub>2</sub>/SBA-15 (□) for JP-5 light fraction (841 ppmw-S).





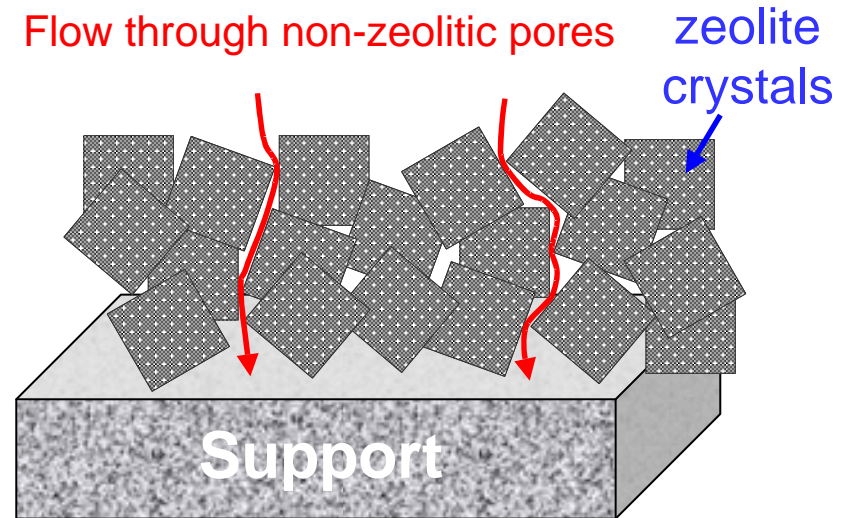
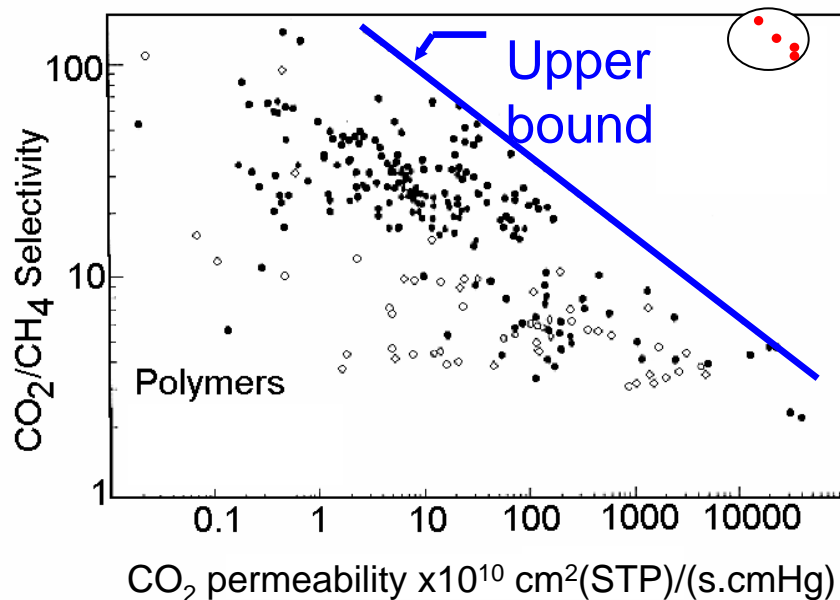
# Membrane Technology



# Zeolite Membrane Performance

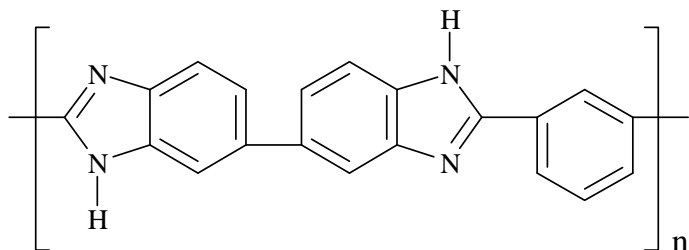
Alan R. Greenberg and Richard D. Noble  
University of Colorado at Boulder

## Superior performance to polymeric membranes



# Polymer-Metallic Composite Membranes

Alan R. Greenberg and Richard D. Noble  
University of Colorado at Boulder

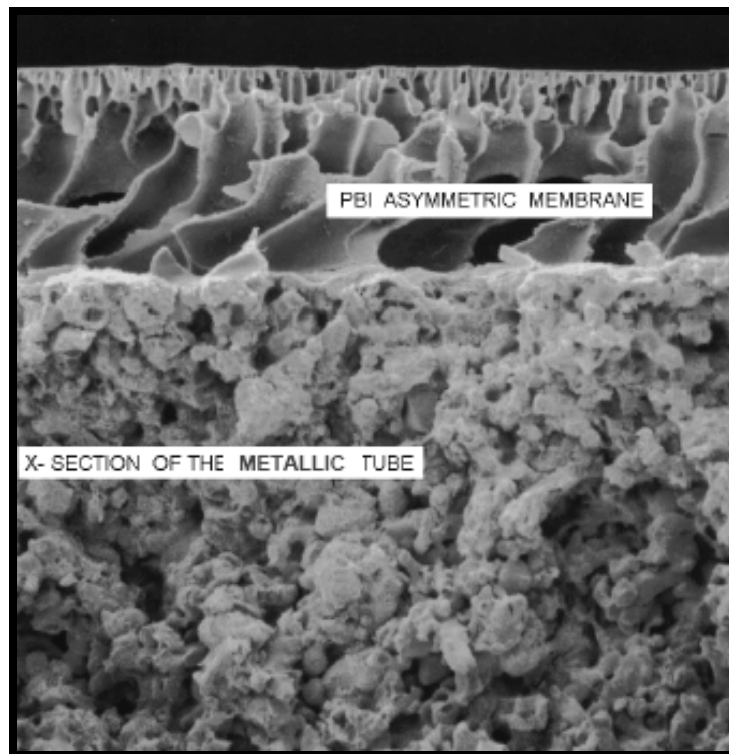


**High Tg polybenzimidazole (PBI)- based Composite Membranes**

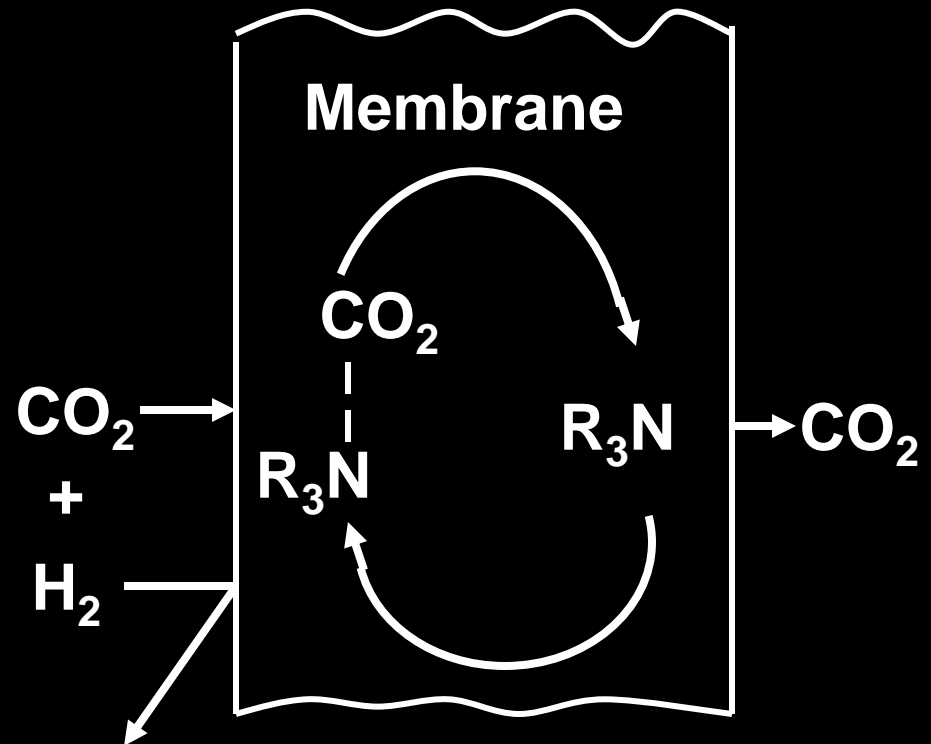
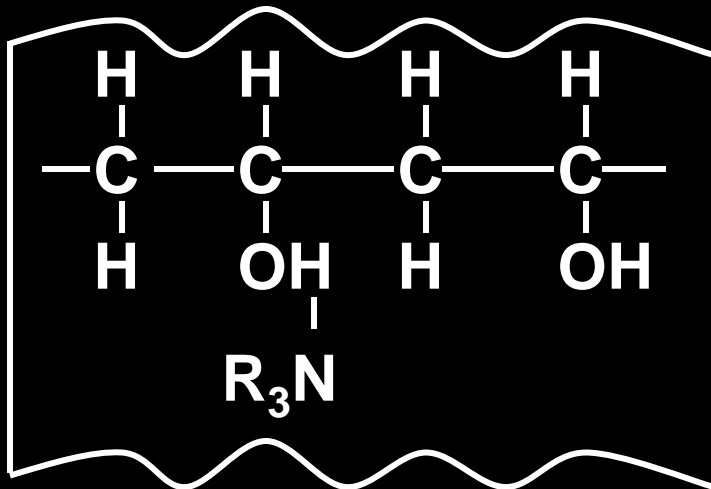
**Thermally stable ( $T_g \sim 450^\circ\text{C}$ ): Facilitates process integration**

**Chemically resistant: Sulfur tolerant at operation temperatures**

**Optimize % CO<sub>2</sub> capture and minimize cost**

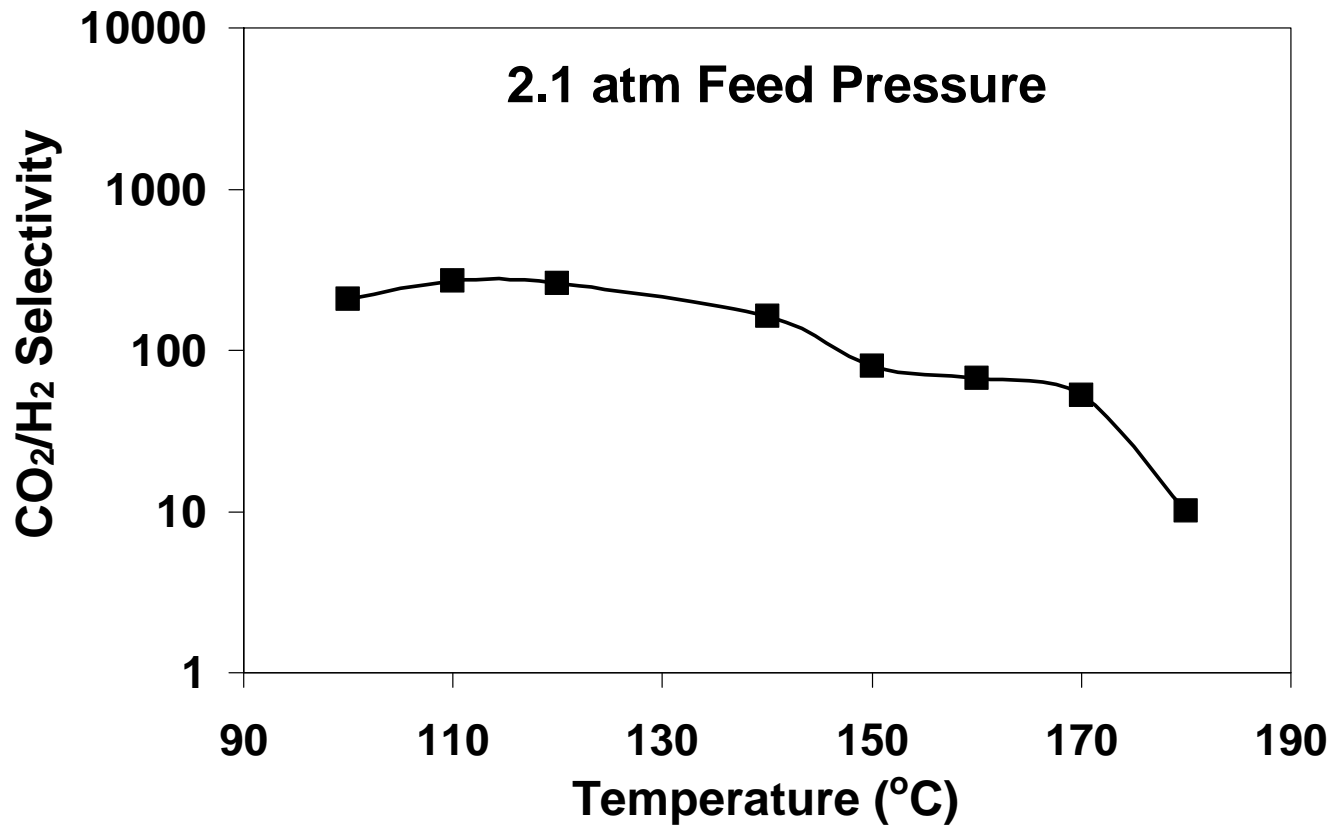


Example: Polyvinylalcohol-  
Containing Amine Membrane

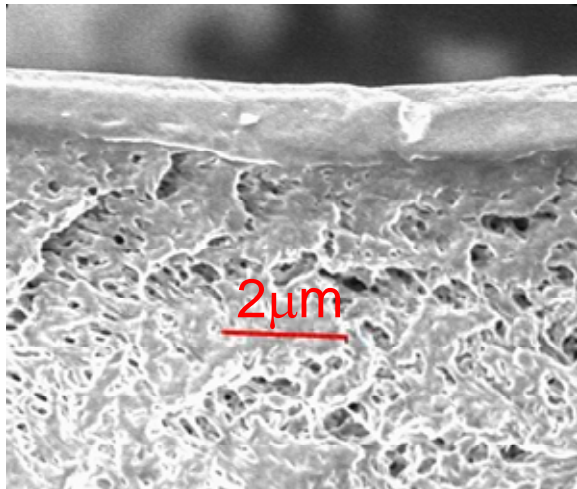




## High CO<sub>2</sub>/H<sub>2</sub> Selectivity Obtained



## Fouling Resistant Membranes



**Coating**

**PSf Support**

